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Fall 2019

MATH 712-001: Numerical Methods II

M. Siegel

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MATH 712: Numerical Methods II

Fall 2019 Graduate Course Syllabus

NJIT Academic Integrity Code: All Students should be aware that the Department of Mathematical Sciences takes the University Code on Academic Integrity at NJIT very seriously and enforces it strictly. This means that there must not be any forms of plagiarism, i.e., copying of homework, class projects, or lab assignments, or any form of cheating in quizzes and exams. Under the University Code on Academic Integrity, students are obligated to report any such activities to the Instructor.

COURSE INFORMATION

Course Description: Numerical methods for the solution of initial- and boundary-value problems for partial differential equations, with emphasis on finite difference methods. Consistency, stability, convergence, and implementation are considered.

Number of Credits: 3

Prerequisites: MATH 614, MATH 331 or departmental approval, and proficiency in a computer programming language (MATLAB).

Course-Section and Instructors

| Course-Section | Instructor |
|----------------|---------------------|
| Math 712-001 | Professor M. Siegel |

Office Hours for All Math Instructors: [Fall 2019 Office Hours and Emails](#)

Required Textbooks:

| | |
|----------------------|--|
| Title | <i>Finite Difference Methods for Ordinary and Partial Differential Equations</i> |
| Author | Randall J. LeVeque |
| Edition | July 2007 |
| Publisher | SIAM |
| ISBN # | 978-0898716290 |
| Optional Text | <i>Finite Difference Schemes and Partial Differential Equations</i> , by J. Strikwerda, SIAM, Philadelphia, 2004; ISBN 0-898715679 . |

University-wide Withdrawal Date: The last day to withdraw with a **W** is **Monday, November 11, 2019**. It will be strictly enforced.

POLICIES

DMS Course Policies: All DMS students must familiarize themselves with, and adhere to, the **Department of Mathematical Sciences Course Policies**, in addition to official **university-wide policies**. DMS takes these policies very seriously and enforces them strictly.

Grading Policy: The final grade in this course will be determined as follows:

| | |
|--------------|-----|
| Homework | 50% |
| Midterm Exam | 20% |
| Final Exam | 30% |

Attendance Policy: Attendance at all classes will be recorded and is **mandatory**. Please make sure you read and fully understand the **Math Department's Attendance Policy**. This policy will be strictly enforced.

Exams: There will be one midterm exam held in class during the semester and one comprehensive final exam. Exams are held on the following days:

| | |
|-------------------|------------------------|
| Midterm Exam | TBA |
| Final Exam Period | December 14 - 20, 2019 |

The final exam will test your knowledge of all the course material taught in the entire course. Make sure you read and fully understand the **Math Department's Examination Policy**. This policy will be strictly enforced.

Makeup Exam Policy: To properly report your absence from a midterm or final exam, please review and follow the required steps under the DMS Examination Policy found here:

- http://math.njit.edu/students/policies_exam.php

Cellular Phones: All cellular phones and other electronic devices must be switched off during all class times.

ADDITIONAL RESOURCES

Accommodation of Disabilities: Disability Support Services (DSS) offers long term and temporary accommodations for undergraduate, graduate and visiting students at NJIT.

If you are in need of accommodations due to a disability please contact Chantonette Lyles, Associate Director of Disability Support Services at **973-596-5417** or via email at lyles@njit.edu. The office is located in Fenster Hall, Room 260. A Letter of Accommodation Eligibility from the Disability Support Services office authorizing your accommodations will be required.

For further information regarding self identification, the submission of medical documentation and additional support services provided please visit the Disability Support Services (DSS) website at:

- <https://www.njit.edu/studentssuccess/accessibility/>

Important Dates (See: **Fall 2019 Academic Calendar**, Registrar)

| Date | Day | Event |
|--------------------|-----|------------------------------|
| September 3, 2019 | T | First Day of Classes |
| September 13, 2019 | F | Last Day to Add/Drop Classes |
| November 11, 2019 | M | Last Day to Withdraw |

| | | |
|----------------------|-------|-----------------------|
| November 26, 2019 | T | Thursday Classes Meet |
| November 27, 2019 | W | Friday Classes Meet |
| November 28-29, 2019 | R-F | Thanksgiving Recess |
| December 11, 2019 | W | Last Day of Classes |
| December 12, 13 2019 | R & F | Reading Days |
| December 14-20, 2019 | F - R | Final Exam Period |

Course Outline

1. REVIEW OF FINITE DIFFERENCE APPROXIMATIONS FOR ODE'S (CH. 1 AND 2):

- Deriving finite difference approximations
- Local truncation error
- global error
- stability, consistency, and convergence

2. ELLIPTIC EQUATIONS (CH. 3 AND 4):

- Finite difference schemes for Poisson's equation
- Jacobi, Gauss-Seidel, SOR methods
- Conjugate gradient and GMRES
- Basics of multigrid

3. PARABOLIC PDE'S (CH. 9):

- Finite Difference schemes
- truncation error, order of accuracy
- stability theory, convergence
- stiffness of heat equation, Von Neumann Analysis
- Higher dimensional equations, ADI scheme

4. HYPERBOLIC SYSTEMS OF PDE'S (CH. 10):

- Finite difference schemes: Lax-Wendroff scheme, Leapfrog scheme, more general multi-step schemes
- Truncation error, consistency
- Stability, Von Neumann analysis, CFL condition
- Dissipation and dispersion
- Numerical methods for hyperbolic systems

OTHER TOPICS (TIME PERMITTING):

- Spectral methods
- Fully nonlinear PDE's

*Updated by Professor M. Siegel - 9/1/2018
Department of Mathematical Sciences Course Syllabus, Fall 2019*